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2020-07-03

Vartiainen , J & Kumpulainen , K 2020 , ' Playing with science : manifestation of scientific play in early science inquiry ' , European Early Childhood Education Research Journal , vol. 28 , no. 4 , pp. 490-503 . https://doi.org/10.1080/1350293X.2020.1783924

http://hdl.handle.net/10138/318366
https://doi.org/10.1080/1350293X.2020.1783924

European Early Childhood Education Research Journal

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/recr20

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To cite this article: Jenni Vartiainen & Kristiina Kumpulainen (2020) Playing with science: manifestation of scientific play in early science inquiry, European Early Childhood Education Research Journal, 28:4, 490-503, DOI: 10.1080/1350293X.2020.1783924

To link to this article: https://doi.org/10.1080/1350293X.2020.1783924

Published online: 25 Jun 2020.

EUROPEAN EARLY CHILDHOOD EDUCATION RESEARCH JOURNAL
2020, VOL. 28, NO. 4, 490–503
https://doi.org/10.1080/1350293X.2020.1783924

Playing with science: manifestation of scientific play in early science inquiry

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ABSTRACT
Drawing on sociocultural theorizing, this case study investigates and unpacks the qualities of *scientific play* during children's inquiry-based science activities framed by imagination and play (i.e. Poetry Science). The data were gathered in Finnish preschool groups with children aged five to six years old (N: 31) over a five-week period. The data consist of video recordings, observational field notes, and artifacts, subjected to multimodal analysis. The results show that scientific play that manifested throughout young children's inquiry process has the following four characteristics: (i) creating and maintaining an imaginary science situation, (ii) assigning new meanings to science objects and processes, (iii) combining imaginary situations and problem solving, and (iv) engaging in science talk in an imaginary situation. The study shows how imagination and play are important elements of children's science inquiry, with implications for early science education.

KEYWORDS
Early science education; science inquiry; play; imagination; meaning-making

Introduction

Inquiry-based approaches are widely used in all levels of science education (Minner, Levy, and Century 2010), and their benefits are well recognized in early science education (Samarapungavan, Mantzicopoulos, and Patrick 2008; Peterson and French 2008). Nevertheless, the meaning and goals of science inquiry appear obscure. Among scholars, there are dichotomic views about whether inquiry for example (1) seeks to make children learn science or learn about science, (2) whether inquiry is a cognitive activity or social activity, (3) whether it is about raising and answering questions or posing and revising conceptual explanations and models, and (4) whether inquiry is for demonstrating what we know or investigating how we know and why we believe it (Abd-El-Khalick et al. 2004).

In this study, we hold that science inquiry reaches beyond demonstrating what is known and the learning of science-process skills, such as observing, measuring, and predicting (Lederman, Lederman, and Antink 2013). Science inquiry not only includes science-process skills but also refers to combining these skills with scientific knowledge, scientific reasoning, problem solving, and critical thinking in social environment.

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An inquiry approach to early science education is not uncomplicated as more attention has been directed to implementing it among older children (Fleer 2009). Further, many researchers have argued for the importance of incorporating play in young children's science inquiry (Bulunuz 2013; Andrée and Lager-Nyqvist 2013; Fleer 2013 Akman and Özgül 2015; Caiman and Lundegård 2018; Fleer 2019). For instance, Bulunuz (2013) states that children gain a better understanding about science concepts if they are introduced in playful ways. Also, Fleer (2019) points out that there is an underutilized link between imagination in science education and imagination in play. For her, the key element in play-based science education is the creation of collective scientific narratives together with shared wonderings (Fleer 2019).

Despite this emerging body of research knowledge, the concept of play and what counts as play in the context of early science inquiry remain ambiguous. Further, little is known about how play manifests and what purposes it serves in early science inquiry. At the same time, play and its characteristics are well-studied among young children in other contexts, such as in the field of digital play (e.g. Fleer 2016). By drawing on sociocultural theorizing and Vygotsky's conception of play, this paper redresses this dearth of research by investigating the manifestation of play during inquiry-based science activities in early science education. Specifically, our study maps out the characteristics of scientific play and how these characteristics operate during children's engagement in science inquiry. To these ends, we ask, *How does play manifest in children's science inquiry?* and *How does scientific play mediate children's engagement in science inquiry?*

Conceptualizing play in science inquiry

Following a sociocultural approach to play, in this study we understand play as developing via a process in which a child's psychological functioning and social and material conditions meet (Fleer 2013). Within this approach, play and imagination are not reduced to merely the motivators of science activities, but rather they are central to the actual meaning-making process in which children construct science practices and knowledge socially and culturally.

According to Vygotsky (1967), the essence of play is the creation of imaginary situations. Play develops from unsatisfied desires, and because children are naturally curious to find out how the world around them functions via testing and exploring (Eshach and Fried 2005), imaginary science situations can emerge from children's everyday wonderings about scientific phenomena and desire to investigate. In imaginary science situations, children can adopt the role of a scientist and then act as they believe scientists do (Andrée and Lager-Nyqvist 2013).

Imaginative situations have a dual role in learning – they can lead a child toward reality or away from it (Vygotsky 2004). For instance, when a child engages in a role play of thieves and policemen, she explores the rules of society and hence moves toward reality. In turn, when a child addresses an object with new meanings and changes its purpose, a movement away from reality is observed. However, this dual role of imaginative situations is often present in a child's role play concurrently (e.g. the child uses a bench as a police car whilst playing thieves and policemen).

Vygotsky argues that science is impossible without imagination (Vygotsky 1987a). The characteristics of play are that children use imagination to imbue objects with new meanings (Vygotsky 1967). Hence, for science education, material tools and activities that foster the transition to the imaginary situation are central. The transition can be triggered with stories and narratives, such as in the Playworlds method (Lindqvist 1996) and in the Scientific Playworlds model (Fleer 2019), or with playful pivots, such as puppets, that children can imbue with new meanings.

An imaginary situation can support children's developing understanding of scientific concepts and processes whilst imagination and realistic problem solving merge (see also Hakkarainen 2008). Here, language plays an important role as a social and cultural tool used to share and co-create knowledge of scientific concepts and processes. Science talk can be understood as children's use of scientific concepts, describing or planning scientific processes, and presenting and evaluating results. However, scientific concepts do not naturally develop from everyday concepts through imagination and play but instead require social and cultural scaffolds (Vygotsky 1987a). That is, the process of transforming everyday concepts into scientific concepts can be aided by play and imagination (Fleer 2019). Further, an imaginary situation can encourage children to produce talk that fosters their sense making and problem solving (Caiman and Lundegård 2018). These characteristics of play served as a conceptual framework for the current study to investigate the qualities of scientific play.

Study

This study is situated in three Finnish preschools with children aged five to six years old (N: 31) over a five-week period in which the researchers and teachers realized a teaching unit – called Poetry Science – described below.

Poetry science method

Poetry Science is a pedagogical method to engage young children in science inquiry through imagination and play. Poetry Science merges science inquiry, imaginative poems and play to form a space in which young children can play an active role in co-producing knowledge and science practices (Vartiainen and Kumpulainen 2019).

The poems of the method are designed to trigger children's imagination, curiosity, and previous experiences with the scientific phenomena at hand. The shared story-reading and -telling helps children to bring forth or build their everyday concepts about gas formation and state changes of water, for example. Poetry Science method foster the creation of imaginary situations as poems and related graphics are whimsical and spark children's curiosity. Children's engagement in science activities benefit from approaches that exploit fairy tales and poems as starting points (Kalogiannakis, Nirgianaki, and Papadakis 2018; Mutonyi 2016).

The flow of the Poetry Science sessions realized in this study included the following inquiry phases, modified from Pedaste et al. (2015): (i) orientation, (ii) investigation, and (iii) conclusion. The playful pivot (Vygotsky 1967), a finger puppet named 'Elliphant', was used in addition to the poems to trigger the transition to the imaginary situations. The material tools as lab coats and safety goggles served to foster the children's entry into an imaginary situation, and the children could imagine themselves transforming into 'scientists', who were welcome to ask questions, wonder, observe, measure, hypothesize, test, communicate, and extend the experiments. In orientation phase, the children and teacher co-created questions, aims, or hypotheses for inquiry. The children were also introduced to pivotal concepts related to the upcoming experiment. This phase was scaffolded by Elliphant the puppet, which was operated by the teacher (Figure 1).

To conduct their experiments, the children gathered around tables where the investigation phase would take place. However, the children were not expected to sit in front of the tables the whole time; the tables serve as the starting point for investigations. The investigation phase included planning the experimentation, collecting data by making observations and measuring, and wondering (Pedaste et al. 2015). Each child had a partner to conduct the experiment with, but if they wanted, they could cooperate with other children too. As an example of investigations, the children were introduced to a problem stated in a narrative in which Elliphant needs help to inflate balloons since it cannot blow up balloons. Through this narrative, the children were engaged to find out a chemical way to inflate balloons through a reaction between baking soda and vinegar, which forms CO_2 gas. The experiments were open by nature, and they steered the children to perform many kinds of observations. They also invited the children to test and refine the process rather than forcing the children to follow a step-by-step recipe (Figure 2).

To close the investigations and discuss the findings, the children and the teacher moved into the concluding phase. The children invited Ellephant to hear the results they had obtained. This way the children were able to practice how to communicate about the findings and the inquiry process. Since the tasks were open-ended, the children were able to construct different kinds of results according to the particular viewpoint they had decided to follow. For example, in the balloon experiment described above there were many possible outcomes – none of them more correct than the others. The children discussed and evaluated their aims, methods, and results.

Data collection

The data consist of video recordings (34 h), observational field notes, and the children's artifacts from five Poetry Science sessions. Each session lasted approximately 45 min and was

Figure 1. Orientation phase with the finger puppet called Elliphant.

Figure 2. Children gather around tables to receive instructions for the experiments.

captured via three movable video cameras. Prior to the implementation of the study, permission to perform this research was acquired at the municipal level and from the children's guardians. The children were made aware that they could at any point tell the researcher to stop filming and documenting their work. The researcher was also sensitive to any potential instances of children's nonverbal expressions of unwillingness to be recorded.

Data analysis

The qualitative data analysis of the video recordings (34 h), observational field notes, and the children's artifacts proceeded in four phases. In the first phase, the video data, supported by field notes, were open-coded with the MAXQDA program to identify interactional episodes in which children engaged in scientific play. Scientific play was accounted for as an imaginary situation in which objects and actions are imbued with new meanings (Vygotsky 1967). In the second phase, the selected episodes – being the unit of analysis – were transcribed using a multimodal analysis grid (Taylor 2014), which allowed us to simultaneously scrutinize the children's interactions as mediated through various modalities. In phase three, the episodes were labeled two ways. The first labeling aimed to point out the situations that held some characteristics of play. These initial labels were extracted from previous research concerning the characteristics of play. The second labeling was about identifying in play situations the children's inquiry practices that had emerged in different phases of inquiry. According to the labeling, common trends were identified, and groups were refined and renamed according to the characteristics of play that described children's situated practices in three different phases of inquiry. In phase four, representative excerpts were chosen from the refined groups to address the following research questions: *How does play manifest in children's science inquiry?* and *How does scientific play mediate children's engagement in science inquiry?* Table 1 provides an example of our multimodal analysis of the data. Figure 3 offers an example of the corresponding situations from the video data.

Findings

The analysis revealed that in the context of Poetry Science, scientific play emerges through four characteristics, including (i) creating and maintaining an imaginary

Table 1. An excerpt of multimodal analysis grid transcription (video excerpt 001073).

Turn	Sign maker	Vocalization	Action	Gaze	Gesture/ facial expression	Posture/proxemics/haptics
Pair 1 is performing the second experiment. They have attached the balloon to the funnel.						
1	Pair 1 P	N/A	Pokes the soda in the funnel and balloon using the thin end of the spoon	Toward the funnel	Focused	Works in front of himself, sitting on his chair, with his elbows pointing to the sides
2	Pair 1 T	'I'll put some fuel in here.'	Brings the pipette near to the mouth of the funnel	Toward the funnel	Face not seen	Standing, takes a step toward Pair 1 P and leans toward the funnel with her whole body, moving a little about
3	Pair 1 T	N/A	Squeezes the pipette	Toward the funnel	Focused	Standing still, leaning toward the funnel
4	Pair 1 T	(screams and laughs)	Watches the reaction	Toward the funnel	Excited, delighted, mouth open	Standing, leaning toward the funnel
5	Pair 1 P	(shouts)	Moves the balloon and the funnel quickly to the left, farther from Pair 1 T	Toward the funnel	Defending	Holds his right hand lifted, with the spoon in it
6	Pair 1 P	'Look at this, look at this!'	Moves the balloon and the funnel toward pair 1, then in front of himself and looks in the funnel	Toward the funnel	Face not seen	Works in front of himself, sitting on his chair, with his elbows pointing to the sides

science situation, (ii) applying new meanings to science objects and processes, (iii) combining imaginary situations and problem solving, and (iv) engaging in science talk in an imaginary situation.

Creating and maintaining an imaginary science situation

The results show that the material tools played an important role in creating and maintaining the imaginary science situations. In the orientation phase, the playful pivot 'Elliphant' was the central tool used in creating the imaginary science situation alongside with poems. The children's engagement in the imaginary science situation was observed

Figure 3. A moment related to Table 1 in which children are cheering and laughing as the reaction occurs after adding some 'fuel' into the funnel.

Figure 4. The children direct their communication to the puppet.

when they directed their communication toward Elliphant. The children's posture and gaze were directed toward Elliphant rather than toward the teacher (Figure 4). During the orientation phase, the teacher was needed to trigger an imaginary situation, but it was evident that when the children entered the conclusion phase to report their results to Elliphant, the children were able to maintain the imaginary situation without the teacher's input. The children called for Elliphant to join them, and they proactively shared their findings with Elliphant. During the investigation phase, the children maintained the scientific play situation by drawing on scientific accessories, such as safety goggles and lab coats. The children reminded one another to wear goggles and argued that wearing a lab coat is important for scientists.

Our study also reveals how the children were emotionally involved in their scientific play. In their speech, the children referred to Elliphant as having emotions. Laughter, excitement, and joy were an important element of the children's observations and testing of new ideas. Even when the children failed, they showed positive emotions and seemed empowered to design a new way to conduct the experiment. In the conclusion phase, the children showed excitement and enthusiasm for sharing their results with Elliphant.

Applying new meanings to science objects and processes

In the scientific play situations, the children typically addressed one another as scientists who had the capabilities to produce solutions to the problem at hand. This was evident in those situations in which the children turned to one another instead of the teacher when they needed help and/or advice. The children also referred to themselves or other children as doctors or scientists.

The children assigned multiple new meanings to the material objects. The new meanings emerged in situations in which the children described their observations and when they played with science experiment tools and artifacts. For instance, the children engaged in play by pretending that pipettes were guns, vinegar was fuel, and an inflated balloon was a microphone, as in the following excerpt 4903: The children started to figure out how they could make a balloon inflate utilizing an empty bottle, a funnel, and a balloon. They carefully watched what the other children were doing. They looked to the pairs at the other table, and they observed what their peers were doing around their own table. The children did not talk to each other, but they proceeded with their task in a similar way to that of the other pairs. They communicated and expressed their emotions to each other through smiles and laughter. Eventually, they succeeded in filling up the balloon with a small amount of gas, which made them very happy – evidenced by smiles and laughter. The boy felt the balloon and nudged it so that it started to jiggle. Another pair of children on the other side of the table celebrated their success, and they happily sang, '*la-la-la-la*'. The boy then grabbed the balloon attached to the bottle and brought it close to his mouth, pretending that it was a microphone and pretended to sing. The girl who was his partner repeated the boy's action and sang into the 'balloon microphone', too. Through this interaction with the social and material world, the boy assigned new meaning to the balloon in the form of a microphone. In this situation, the inquiry artifact turned into a play artifact. An imaginary situation can unleash children's creativity in inquiry activities and help children to connect science to their own cultures by imbuing objects with new meanings (Figure 5).

During the conclusion phase, the artifacts took on new meanings, and the children suggested ideas regarding how to utilize these new meanings in other contexts. For example, a group of children in excerpt 4929 gave balloons placed in a basin a new meaning as a balloon pool for Ellephant.

Combining an imaginary situation and problem solving

The scientific play challenged the children's imagination and engaged them in problem solving in all phases of the inquiry. During the orientation phase, the discussion with Elliphant was intentionally initiated by the teacher, leading to a situation in which the children agreed to solve a problem to help Elliphant. The children's engagement in problem solving was evident from their vocalizations when they promised Elliphant that they would perform investigations in order to find a solution. Problem solving was constant during the investigation phase, and the children vocalized their problem solving, for example, by asking what-if questions such as 'what if we put these [reactants] in a different order?' The children also invented and tested new ways to perform explorations or experiments. The children engaged in negotiative conversations, for example, in excerpt 107, the children tested how to inflate a balloon with baking soda and vinegar.

Figure 5. The children are assigning a new meaning to the balloon.

They initially failed but then started a new attempt. One child stated in a determined way, ‘We need more of this; I have an idea what to do!’ Another child continued excitedly, ‘Let’s put the balloon here, when it’s fixed, then we kind of put it here (makes a clicking sound), then it kind of makes gas, then we hold … like then (makes a sound) … “–” I know how we … We need more of the … water’, she explained to the other child working with her. ‘We need more … uh … well … vinegar. We need more vinegar’, the other child corrected.

During the conclusion phase, the children not only reported successful processes to Elliphant but also described their failures and illustrated how they turned failure into success. Moreover, the children gave Elliphant advice about how the results could be utilized in future. For example, after the children described how they had invented a method for Elliphant to use in inflating balloons, they critically evaluated the method. They also explained how slow and complex the method was and suggested that Elliphant could use some help, as in excerpt 108, when the children described the process of inflating the balloons for Elliphant: ‘first we put vinegar in the bottle and baking soda inside the balloon. Then we attached the balloon and whooom! It inflated!’, one child described and spread her hands to illustrate the inflation. ‘We know that when you put in more vinegar, you can get a bigger balloon’, another child elaborated. Elliphant was excited and told the children that he was going to inflate a hundred balloons. ‘Well, it’s REALLY hard work’, one child warned. ‘You will need help’. ‘We can help you!’ another child suggested. ‘Yes, we can!’ others cheered. The emotional engagement was evident as the children expressed their willingness to help Elliphant inflate more balloons (Figure 6).

Engaging in science talk in an imaginary situation

During the orientation phase, the children used scientific expressions when they described their earlier experiences with scientific phenomena. This was evident, for example, in excerpt 74, in which, before their investigation, the children described the process of rain formation to Elliphant, who was wondering how water could end up in the sky.

Figure 6. A child explains the process to Elliphant.

'Clouds! As water vapor', answered one child. She continued: '[rain forms] from water vapor. Because that vapor then rains down'. She demonstrated with her hands how water vapor goes up and then rains down. Then other children echoed 'water vapor', and a child continued explaining, 'It's like, it's like water raises as this kind of water vapor then it rises up in the clouds and then it like falls down'. 'As water', another child clarified.

During the investigation phase, the children described scientific processes and used scientific concepts as they considered new ways to conduct the experiments. When the children shared their findings with Elliphant, they engaged in scientific talk in an imaginary situation by describing scientific processes and evaluating their results. In excerpt 49299, a child described her and her peer's process: 'At first, we tested so that we put a little of both [reactants], but then I got an idea that when we put more [reactants], the balloon also gets bigger! And that's what we got!' The girl showed a balloon to Elliphant.

In the investigation phase, the children often referred to the vinegar as water and to the baking soda as sugar or flour. However, when the children described the process to Elliphant, they used the right terminology for the reactants. In addition to mere description, they were able to involve critical thinking by describing the variables that produced different sizes of balloons.

Discussion

The aim of this study was to investigate how imagination and play manifest in young children's science inquiry – that is, *scientific play*. The results show that in the context of this study, scientific play that emerge throughout inquiry has four characteristics: (i) creating and maintaining an imaginary science situation, (ii) assigning new meanings to science objects and processes, (iii) combining imaginary situations and problem solving, and (iv) engaging in science talk in an imaginary situation. These characteristics were present throughout the different phases of the science inquiry, as shown in Table 2.

During the orientation phase, the children rarely assigned new meanings to science objects or scientific processes. This can be explained by the pedagogical design of the activity, which did not afford the children opportunities to engage in observations or hands-on engagement with scientific objects.

The study shows how the children used playful pivots and scientific accessories to create and maintain the imaginary science situation. In the Playworlds method, an imaginary situation is often created utilizing shared imagination and material tools (Lindqvist 1996; Fleer 2019). In this study, material tools were used to create and maintain the imaginary situation but also to strengthen the child's identity as a competent meaning maker. The teacher's support was needed to create an imaginary situation, but the children were able to maintain it independently when material tools were offered in support.

For young children, engaging in inquiry is a demanding task, and it requires scaffolding and modeling (Harlen 2014). The imaginary situation and problem solving merged in the children's actions, and they engaged in problem solving in different phases of the inquiry. Through the imaginary situations and utilizing Elliphant the finger puppet, the teacher can use communicative practices that model how everyday wondering can be turned into an inquiry process. Through joint participation in an imaginary science situation, the teacher

Table 2. Manifestation of scientific play during science inquiry.

	Orientation	Investigation	Conclusion
Creating and maintaining an imaginary science situation	The children actively engaged in the creation of shared imaginary science situations. A playful pivot and material tools were used to strengthen the transition to the imaginary situation.	The children's emotions and meaning making were connected in an imaginary science situation. The children assigned one another the roles of a capable agent and experimenter as they asked for help from other children rather than turning to a teacher. The children maintained the scientific play by reminding other children to keep wearing the tools (lab coats and safety goggles) that indicates they are researchers in the scientific play.	The children triggered an imaginary situation by utilizing a playful pivot. The children were able to independently maintain a shared imaginary situation.
Applying new meanings to science objects and processes		The children applied new meanings to their scientific tools (e.g. pipettes and vinegar). The children described observations by applying new meanings to scientific processes.	The children applied new meanings to the artifacts produced during the inquiry.
Combining an imaginary situation and problem solving	The children agreed to engage in problem solving or an investigation that emerged from an imaginary science situation.	The scientific play environment encouraged the children to improvise and suggest new ways to investigate and experiment.	The children suggested solutions that reflected real life in response to the problem initiated in an imaginary situation. The children evaluated the solution and suggested modifications needed to implement it in practice.
Engaging in science talk in an imaginary situation	The children described their prior knowledge of science concepts or scientific processes.	The children used non-scientific and scientific concepts during investigations. Children described, discussed and negotiated about scientific processes connected to the experiments.	The children challenged and evaluated the results and claims that were presented in the conclusion phase. The children used scientific concepts when they addressed their speech to the Elliphant in an imaginary situation.

helps the children to obtain the cultural practices of science and play becomes a scaffold for the whole inquiry process rather than a motivator to trigger an inquiry.

The imaginary science situation allowed the children to develop their everyday concepts into scientific concepts by engaging them in the science inquiry process. Hakkarainen (2008) has proposed that imaginary situations can be developed so they combine play and realistic problem solving. The inquiry approach seeks to solve questions and problems that are meaningful for children from their everyday life, and therefore it benefits an approach that combines play and real problem solving. Through *scientific play*, children were able to use play and imagination as a bridge between the familiar and the unfamiliar, such as for example how Fleer (2013) underscores the role of play in her studies. Moreover, it helps children to reconstruct meanings in new contexts. The children were found to assign new meanings to scientific equipment, observations they made, and the artifacts they produced as results. In Vygotsky's idea of play, how meanings of objects change due the interaction with material world is essential. New meanings that children address to science-related objects or processes allow them to move back and forth between every-day and scientific concepts and thus approach the forming of a conceptual understanding about this relation.

Vygotsky (1987b) argues that words are the starting point for conceptual development. Therefore words, labels, and speech combined with experiences of scientific concepts are essential. The study showed that the children engaged in science talk while communicating with one another and the playful pivot. This talk contained scientific concepts and descriptions of processes. Imaginary play situations can foster the labeling of scientific concepts children produce while interacting with them. As Fleer and Pramling (2014) stresses, a scientific concept is not just a word but the development of scientific concept holds the multiplicity of moving between the everyday concepts and scientific concepts, which will eventually lead to a situation where children can think and act using scientific concepts.

Altogether, the findings suggest that inquiry that embeds scientific play can offer children rich opportunities to practice scientific processes, create science-related speech, and use play as a means to seesaw between every-day and scientific concepts. Thus, we suggest that the pedagogy of early science education should be firmly built upon play that embraces imagination and inquiry.

Conclusions

This study has important implications for early science education. Specifically, the results suggest that implementing science education through scientific play in which imagination and play are joined to science inquiry allows children to engage in science inquiry as active producers and users of knowledge. Moreover, we consider that science inquiry should reach beyond demonstrating what is known (Lederman, Lederman, and Antink 2013). Further, Vygotsky states that imagination is the only way to think beyond what is already known. Therefore, we claim that combining science inquiry and imaginative situations has potential to meet the goals of inquiry in the context of early childhood science education.

Scientific play activated the children's positive emotions throughout the inquiry, which is an essential feature of meaning making and learning (Vygotsky 1978). Here, appreciating children's own cultures, languages, and ways of being supported diverse children's opportunities to engage in science inquiry in meaningful and culturally sensitive ways. Material tools, such as scientific accessories and science equipment, were also identified as vital playful pivots that triggered and maintained the young children's scientific play. In sum, the results show the importance of material tools, the teacher, and the pedagogical context based on Poetry Science pedagogy in creating and maintaining scientific play.

This study was conducted as a short-term intervention with a limited number of participants. Further, the study addressed the children's interaction only during the Poetry Science sessions. The children's scientific play practices outside the sessions were not possible to scrutinize within this research design. In the future, it would be worth investigating how scientific play develops over a longer period of time and how a socio-material environment that is enriched with various material artifacts, including digital technologies, can enhance diverse children's participation in scientific play.

Acknowledgements

This work is part of 'The Joy of Learning Multiliteracy' research and development program supported by the Finnish Ministry of Education and Culture under grant number 3880115. We would like to express our sincere thanks to Emilia Tuovila, Iina Ahola, Jenny Byman, Jenny Renlund, Laura Hytönen, Noora Oksa, Carolina Tallgren and the whole MOI-team.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work is part of 'The Joy of Learning Multiliteracy' research and development program supported by the Finnish Ministry of Education and Culture [grant number 3880115].

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